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PRELIMINARY
LICHEN BIOMONITORING PROGRAM
AND AIR QUALITY BASELINE

IN SELECTED CLASS I WILDERNESS AREAS
OF CORONADO, COCONINO, KAIBAB, PRESCOTT AND TONTO
NATIONAL FORESTS, ARIZONA

COPY

FINAL REPORT

GALIURO WILDERNESS AREA

Arizona, Graham County
Coronado National Forest
Galiuro Wilderness Area

SUBMITTED BY

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INTRODUCTION

Project objectives:

1. Collect, curate, and identify lichen species from selected sites in the Sycamore Canyon, Pine Mountain, Mazatzal, Sierra Ancha, Superstition, Galiuro and Chiricahua wilderness areas.

2. Identify potential sites in each wilderness area for establishing lichen monitoring transects and plots.

3. Identify and collect pollution-sensitive lichen species for elemental analyses from 5-7 reference sites in each wilderness area. Rare species will not be sampled for analysis, but their distribution will be noted.

4. Determine baseline thallus concentrations of sulfur, lead, and copper, using ten replicate samples of one documented pollution-sensitive species from each wilderness area.

5. Prepare and submit a draft report by 28 December 1990.

6. Prepare and submit 3 copies of a final report detailing the results of this study by 11 July 1991. This final report will include:
   a. a map and a brief habitat description of the study sites in each wilderness area, and reasons for their selection.
   b. a preliminary list of lichen species for each wilderness area with relative abundance and substrate data for each species.
   c. a list of pollution-sensitive or potentially pollution-sensitive lichen species for each wilderness area.
   d. color photographs/slides of lichens known or suspected to be sensitive to specified air pollutants for each wilderness area.
   e. baseline concentrations of lead, sulfur, and copper for one indicator species from each wilderness area.
   f. a map of recommended sites for establishing transects and plots for future long-term monitoring.
   g. a list of references, protocols, equipment and supplies used in this study.
   h. other pertinent information or unusual observations.

Lichens as sensitive receptors:

The use of lichens as bioindicators of air quality is a well-documented procedure (Ske 1979; Richardson & Nieboer 1981; Fields & St. Clair 1984; St. Clair 1989; Rope & Pearson 1990). Hale (1983) noted that lichens have been used in three ways to monitor the effects of air pollution on biological systems: 1) elemental analysis of lichen tissues, 2) mapping of all

(or selected) lichen species found in areas adjacent to pollution sources, and 3) transplant studies. Currently, the most common approach involves a floristic survey and elemental analysis of tissues from selected indicator species (St. Clair 1989; Wetmore 1981, 1989).

Because lichens accumulate many different pollutants from atmospheric outwash, lichen tissues (or thalli) provide a record of the kinds and relative quantities of pollutants in any particular airshed (Gough & Erdman 1977; Schutte 1977; Wetmore 1989; Rope & Pearson 1990). Pollution patterns for specific elements can be monitored over time by determining thallus growth rates and elemental concentrations in excised portions of the thallus (Lawrey & Hale 1981). Lichen physiological processes indicate pollution-related damage long before other, more visible changes in color, morphology, or community structure can be detected or even monitored (Sundstrom and Hallgren 1973; Fields and St. Clair 1984).

Lists of pollution-sensitive lichen species have commonly been published in conjunction with floristic and ecological surveys (Wetmore 1981, 1989; Rushforth et al. 1982). As certain lichen species form particular substrates are inherently more sensitive to airborne contaminants, air quality can be effectively monitored be occasionally reevaluating lichen community and/or physiological parameters. Pollution-related changes can then be documented by comparing follow-up data to the original baseline data.

General habitat description for Arizona:

The state of Arizona includes several of North America's major biotic provinces: Sonoran, Chihuahuan, Mojave, Great Basin, and Colorado Plateau deserts; Rocky Mountain, Sierra Madrean, encinal, and pinyon-juniper woodlands; and inland chaparral. Elevation ranges from less than one hundred feet above sea level in Yuma County to over twelve thousand feet in Coconino County. Precipitation varies, but almost all portions of the state are watered to some extent be winter rain or snow and summer monsoons, with occasional chubascos in early fall. The Mogollon Escarpment divides Arizona's two major geologic provinces: the Basin and Range Province to the south and west, and the Colorado Plateau to the north and east. This project has involved a preliminary survey of seven of the eight Class I Wilderness areas in Arizona (figure 1).

General description of the Arizona lichen flora:

With over 600 species reported, Arizona's rich lichen flora results from the state's habitat diversity. The forests of the White Mountains, the Mogollon Escarpment, the Chiricahuas, and other high elevations throughout the state, also the encinal of Cochise and eastern Pima counties, support a rich epiphytic lichen flora. Crustose forms predominate on igneous substrates of the southern deserts and sedimentary rocks of the Colorado Plateau.

Bibliography of lichen studies in Arizona:

Darrow, R. A. 1950. The arboreal lichen flora of southeastern Arizona. Am. Midl. Nat. 42:484-502.

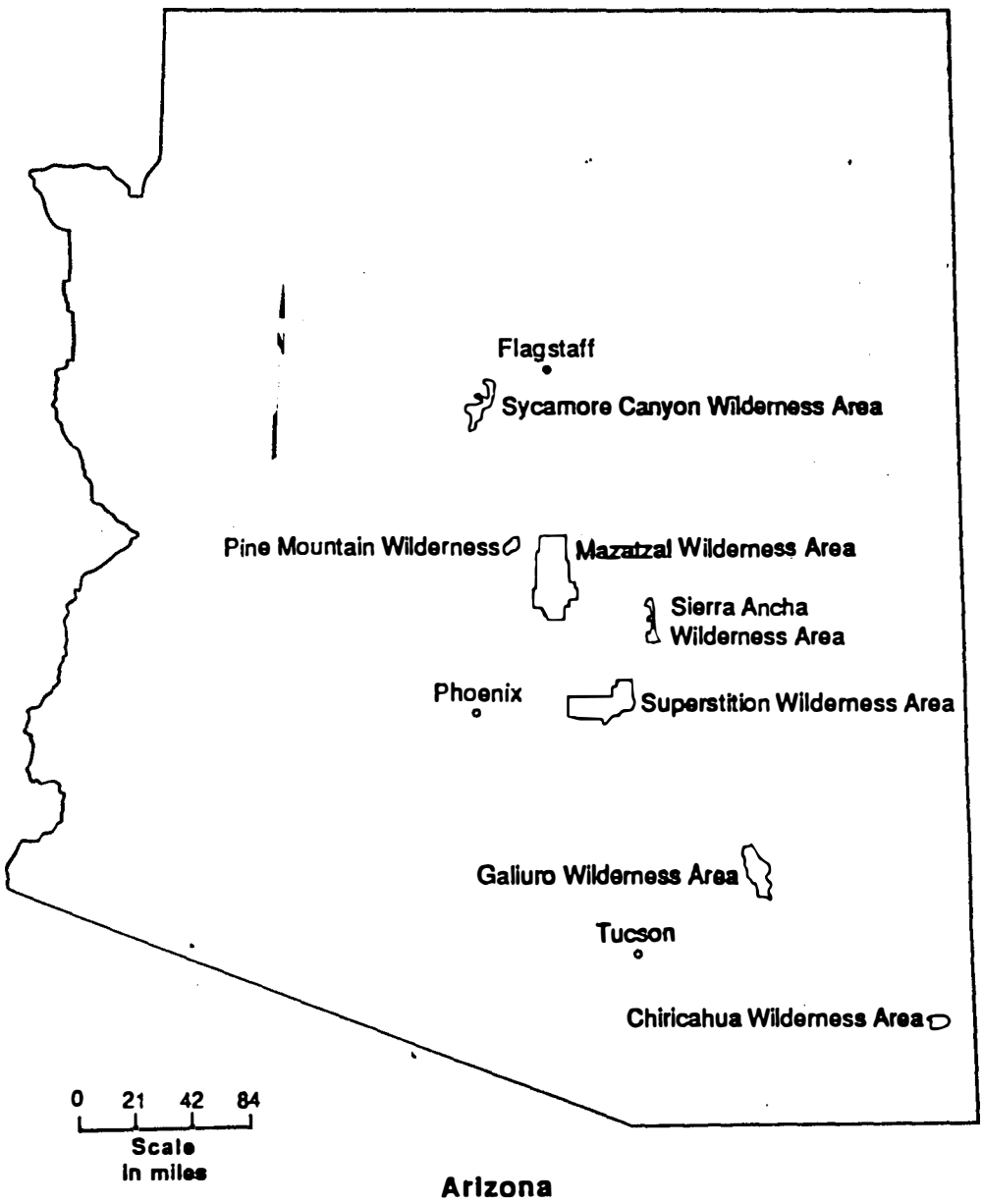
Flagstaff
Sycamore Canyon Wilderness Area
Pine Mountain Wilderness
Mazatzal Wilderness Area
Sierra Ancha
Wilderness Area
Phoenix
Superstition Wilderness Area
Galiuro Wilderness Area
Tucson
Chiricahua Wilderness Area
0 21 42 84
Scale
in miles
Arizona

Figure 1

Flowers, S. 1963. The lichen and moss flora of Betatakin Canyon and vicinity, Navajo National Monument, Arizona. Univ. Utah Div. Biol. Sci. Misc. Pap. 10pp.

Johnsen, A. B. 1965. Some Lichens from West Fork, Coconino County, Arizona. The Bryologist 68: 241-243.

Nash, T. H. 1973. Additions to the lichen flora of Arizona I. The Bryologist 76: 545-547.

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Nebeker, G. T. & L. L. St. Clair. 1984. The lichen flora of Navajo National Monument, Arizona. Mycotaxon 19: 413-422.

Rudolph, E. D. 1953. A contribution to the lichen flora of Arizona and New Mexico. Ann. Mo. Bot. Gard. 40: 63-72.

Weber, W. A. 1963. Lichens of the Chiricahua Mountains, Arizona. Univ. Colo. Stud. Ser. Biol. 10: 1-27.

General habitat description for Galiuro Wilderness Area:

The Galiuro Range is NW-SE trending horst, approximately 40 miles long. Predominant lithologies include Precambrian granite and younger sedimentary rocks. Elevation in the wilderness area starts around 4000 ft, and the highest point is 7663 ft. Bassett Peak. Plant communities include semi-desert grasslands, chaparral, encinal and mixed conifers.

Likely pollution sources impacting the Galiuro Wilderness Area include the Tuscon metropolitan area and the copper smelters at Globe and Morenci. The San Manuel copper smelter in the valley west of the wilderness area is possibly an immediate source of serious pollution. Metropolitan Maricopa County may also contribute to regional pollution over the Galiuro Range.

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METHODS

Procedures for selecting reference sites:

Specific locations for specimen collection (reference sites) in the wilderness were determined in consultation with Forest Service personnel. Sites were selected for accessibility, substrate diversity and habitat diversity. Specifically, occurrence of unusual geologic substrates, vascular plant communities, soil types, mesic canyons, and spring or wet wall areas were given particular consideration. Baseline data from the reference sites (species diversity, relative abundance, and elemental analysis data for indicator species) forms the foundation for evaluating future air pollution-related changes in lichen communities

Collection, preparation and identification of lichen specimens:

Because lichen distribution is directly influenced by substrate, moisture, and sunlight, all available substrates and habitats around each reference site were carefully examined. Small amounts of each lichen species was removed directly from the substrate where possible, or, depending on the species, with small pieces of bark, soil or rock.

Specimens were put in carefully labeled paper sacks and taken to the BYU Herbarium of Nonvascular Cryptogams, where they were washed, curated, and placed in permanent herbarium packets labeled with collection site, habitat and substrate information. Species were identified using standard lichen keys and taxonomic treatises. Where appropriate standard chemical and thin-layer chromatography techniques were used to finalize species identifications. A permanent collection of the lichen species from each reference site has been prepared and will be maintained in the BYU Herbarium of Nonvascular Cryptogams. As requested by the Forest Service a set of duplicate specimens will be sent to the Lichen Herbarium at Arizona State University.

Collection of lichen thalli for laboratory analyses:

After careful consideration of species abundance, substrate, growth form, documented/suspected pollution sensitivity, and distribution patterns of the lichens at each reference site, 3-5 taxa were designated as indicator species for all laboratory chemical analyses.

At all reference sites sufficient material (10-15 grams) of each indicator species was collected for laboratory analyses. This material was stored in Hubco cloth bags to prevent sulfur contamination. One or two indicator species from one reference site was analyzed for sulfur, lead and copper, some of the most common air pollutants in the general vicinity of the wilderness area. Analysis for these pollutants was determined in consultation with Forest Service personnel. Excess material for all indicator species is currently stored in Hubco cloth bags at the Herbarium of nonvascular cryptogams at Brigham Young University.

Determination of elemental concentrations in lichen tissues:

In the laboratory, all surface debris was carefully removed from elemental analysis samples. Samples were then oven dried and ground to powder. Ten 500 mg replicates of one - two indicator species from one reference site in the wilderness were then analyzed for sulfur, lead and copper. Following digestion of samples with nitric and perchloric acid, lead and copper content was assessed using atomic absorption spectrophotometry. Sulfur was subsequently analyzed turbidimetrically using Barium chloride ($BaCl_2$). All analyses were performed by the Brigham Young University Plant and Soil Analysis Laboratory.

RESULTS AND RECOMMENDATIONS

Habitat information and specific location for each reference site:

In Galiuro Wilderness Area poor access and inclement weather prevented sampling except at lower to middle elevations along Deer Creek Trail. Predominant lithologies along lower to middle Deer Creek Trail include Precambrian granite, younger sedimentary rocks, and recent igneous extrusives. Plant communities include semi-desert grasslands, chaparral, and Mexican oak woodlands or encinal, with Chihuahuan Desert elements mixing freely. Elevation along the area sampled averages 1645 msm (5400 ft.). Figure 2 details collections sites for the Galiuro Wilderness Area.

Preliminary observations and recommendations:

1. In spite of limited collecting time in Galiuro Wilderness Area a diverse group of lichen species was collected, consisting of 90 species in 41 genera (see "Checklist of Lichen Species Galiuro Wilderness Area, Arizona" for details). This list represents approximately 50 - 60% of the total lichen flora for the wilderness. All growth forms are represented in the flora. The flora is dominated by crustose species (47% or 42 species) followed by foliose species (39% or 35 species), squamulose species (8% or 7 species), umbilicate species (6% or 5 species) and fruitcose species (4% or 4 species). Rock lichens dominate the flora (62%) followed by bark lichens (26%) and soil lichens (3%).

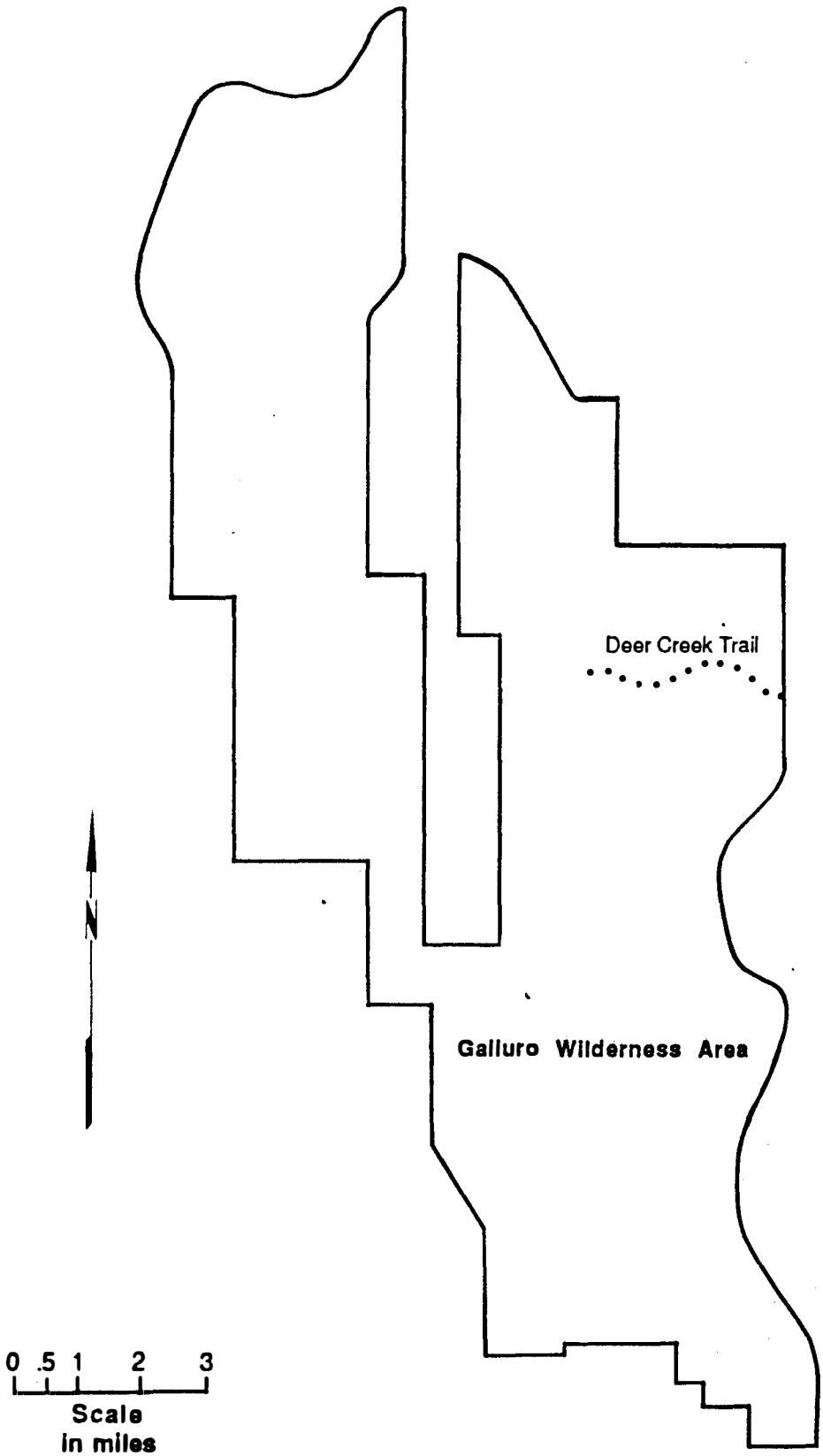
Deer Creek Trail
N
Galluro Wilderness Area
0 .5 1 2 3
Scale
in miles

Figure 2

2. Lower to middle Deer Creek Trail was rich in crustose lichens, both on rock and decorticated wood. Rocky ledges, cliffs and overhangs were particularly good sites of saxicolous lichen diversity.
3. Foliose and umbilicate lichens were also abundant and diverse on the rocks of lower to middle Deer Creek Trail.
4. The bark and wood of live oaks, and the wood of alligator juniper were typically good substrates for foliose lichens along Deer Creek Trail. Some individual pinyon pines also supported diverse lichen floras.
5. Fruticose forms were scant in lower to middle elevations of Deer Creek Trail. However, they may be more abundant in the ponderosa pine stands located at higher elevations.
6. Pollution-related thallus damage was not apparent in samples taken so far.
7. Table 2 contains a list of several lichen species which have been shown to be sensitive to various air pollutants. Photographs of some of these species are included with this report.
8. Elemental analysis data for *Xanthoparmelia cumberlandia* shows elevated sulfur levels (.274%), suggesting the need for further biomonitoring of sulfur dioxide accumulation in this wilderness area. The proximity of Galiuro Wilderness Area to copper smelters in northern Mexico and coal-fired power plants in southeastern Arizona probably accounts for this pattern. Accumulation of lead and copper are well within the normal (low-impact) range for these pollutants. In connection with establishment of a comprehensive lichen biomonitoring program the higher elevation sites in this wilderness need to be thoroughly surveyed.
9. A list of all lichen species collected from all wilderness areas during the course of this study is included for your information (Table 1).

Format of general species list for the Galiuro Wilderness Area:

The following data are recorded for each species in the general species list (all species are listed alphabetically by genus):

1. current epithet (genus & species) with authors, nomenclature generally follows Egan (1987, 1989, 1990)
2. lichen growth form (ie fruticose, foliose, crustose, squamulose, umbilicate)
3. substrates (ie rock, soil, bark, decorticated wood)
4. specific collection site(s)
5. relative abundance (ie rare, locally common, common, abundant)
6. documented pollution sensitivity with appropriate literature citation(s) (ie sensitive, intermediate, tolerant)
7. general comments (including occurrence on atypical substrates, unusual morphology, new species records for Arizona, descriptive information for unidentified specimens.
8. deposition of specimens (ie BYU Herbarium with duplicates to ASU)

CHECKLIST OF LICHEN SPECIES
GALIURO WILDERNESS AREA, ARIZONA

Acarospora chlorophana (Wahlenb. ex Ach.) Massal.
- Growth form: crustose with effigurate margins
- Substrate: on rock (both fractured basalt and tuff)
- Site(s): along Deer Creek Trail
- Relative abundance: rare-common
- Pollution sensitivity: sensitive to sulfur dioxide (Hale, 1982)
- Comments: none
- Deposition of specimens: BYU Herbarium #14000 & 14001

Acarospora schleicheri Hedl. ex. Magnusson
- Growth form: crustose
- Substrate: on rock
- Site(s): near Deer Creek Trailhead
- Relative abundance: rare-common
- Pollution sensitivity: unknown
- Comments: fruiting structures are not well developed on some specimens
- Deposition of specimens: BYU Herbarium #14002 (duplicate specimen sent to ASU) & 14003

Acarospora sp.1
- Growth form: umbilicate
- Substrate: rock
- Site(s): near Deer Creek Trailhead
- Relative abundance: rare
- Pollution sensitivity: unknown
- Comments: thallus orbicular, creamy brown with pits and fissures, KOH-, C-; spores oblong, many per ascus, 6x2.5; epithecium golden
- Deposition of specimens: BYU Herbarium #14009

Acarospora sp.2
- Growth form: crustose
- Substrate: rock
- Site(s): near Deer Creek Trailhead
- Relative abundance: rare
- Pollution sensitivity: unknown
- Comments: thallus orbicular to chinky aerolate, light brown with radiating fissures, KOH-, C-; spores many per ascus, elongate spherical, 2.5x5
- Deposition: BYU Herbarium #14010

Aspicilia alphoplaca (Wahlenb. in Ach.) Poelt and Leuck.
Growth form: crustose with lobed margins
Substrate: on brecciated tuff (rock)
Site(s): along Deer Creek Trail
Relative abundance: rare to locally common
Pollution sensitivity: Sensitive to Sulfur dioxide (Marsh and Nash 1979)
Comments: lobing of thallus highly variable
Deposition of specimens: BYU Herbarium #14007 & 14011 (duplicate specimen sent to ASU)

Aspicilia caesiocinerea (Nyl. ex Halbr.) Arnold
Growth form: crustose
Substrate: rock (tuff)
Site(s): along Deer Creek Trail
Relative abundance: rare-common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14012 (duplicate specimen sent to ASU)

Aspicilia calcarea (L.) Mudd
Growth form: crustose
Substrate: rock (brecciated tuff)
Site(s): along Deer Creek Trail
Pollution sensitivity: unknown
Comments: this is a highly variable and difficult group
Deposition of specimens: BYU Herbarium #14015, 14018 & 14019 (duplicate specimen sent to ASU)

Aspicilia cinerea (L.) Korber
Growth form: crustose
Substrate: rock (brecciated tuff)
Site(s): along Deer Creek Trail
Relative abundance: common
Pollution sensitivity: unknown
Comments: specimen #14016 was of a slightly different color (lighter gray). This may have been due to unusual weathering of the thallus, however, chemical spot tests are consistent for this species.
Deposition of specimens: BYU Herbarium #14014 (duplicate specimen sent to ASU), 14016 & 14020

Aspicilia quartzitica W. Weber
Growth form: crustose
Substrate: rock (brecciated tuff)
Site(s): along Deer Creek Trail
Relative abundance: common
Pollution sensitivity: unknown
Comments: this is a difficult group, ascospores were infrequent
Deposition of specimens: BYU Herbarium #14017

Biatora botryosa Fr.
Growth form: crustose
Substrate: bark at base of juniper
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14060

Buellia erubescens Arnold
Growth form: crustose
Substrate: on decorticated wood
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14062

Buellia punctata (Hoffm.) Massal.
Growth form: crustose
Substrate: decorticated wood
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: tolerant (Wetmore, 1987)
Comments: none
Deposition of specimens: BYU Herbarium #14097

Buellia turgescens Tuck.
Growth form: crustose, subsquamulose
Substrate: rock
Site(s): Deer Creek Trailhead
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14058

Caloplaca cerina (Ehrh. ex. Hedwig) Th. Fr.
Growth form: crustose
Substrate: bark at base of juniper tree
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: sensitive - intermediate (Wetmore, 1987), sensitive to fluorides (LeBlanc, et al., 1972)
Comments: none
Deposition of specimens: BYU Herbarium #14026

Caloplaca chrysophthalma Degel.
Growth form: crustose
Substrate: on Quercus bark
Site(s): along Deer Creek Trail
Relative abundance: rare-common
Pollution sensitivity: unknown
Comments: this species has granular soredia
Deposition of specimens: BYU Herbarium #14023

Caloplaca durietzii Magnusson
Growth form: crustose
Substrate: on decorticated conifer wood
Site(s): along Deer Creek Trail
Relative abundance: common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14022 (duplicate specimen sent to ASU)

Caloplaca flavovirescens (Wulfen) Dalla Torre & Sarnth
Growth form: crustose
Substrate: on rock
Site(s): near Deer Creek Trailhead
Relative abundance: common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14021 & 14028 (duplicate specimen sent to ASU)

Caloplaca fraudans (Th. Fr.) H. Olivier
Growth form: crustose
Substrate: on rocks
Site(s): near Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14111

Caloplaca holocarpa (Hoffm.) Wade
Growth form: crustose
Substrate: on Quercus bark & on bark at base of juniper tree
Site(s): along Deer Creek Trail
Relative abundance: rare-common
Pollution sensitivity: intermediate (Wetmore, 1987)
Comments: none
Deposition of specimens: BYU Herbarium #14024 & 14027

Caloplaca sideritis (Tuck.) Zahlbr.
Growth form: crustose
Substrate: rock
Site(s): at Deer Creek Trailhead
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14029 (duplicate specimen sent to ASU)

Candelariella aurella (Hoffm.) Zahlbr.
Growth form: crustose, areolate
Substrate: rock
Site(s): near Deer Creek Trailhead
Relative abundance: common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14030 (duplicate specimen sent to ASU)

Candelariella deflexa (Nyl.) Zahlbr.
Growth form: thallus rudimentary
Substrate: bark at base of juniper tree
Site(s): along Deer Creek Trail
Relative abundance: rare-common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14025

Candelariella rosulans (Mull. Arg.) Zahlbr.
Growth form: crustose with crenulate margins
Substrate: rock
Site(s): near Deer Creek Trailhead
Relative abundance: common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14031

Candelina submexicana (B. de Lesd.) Poelt
Growth form: crustose with distinct, radiating, elongate lobes
Substrate: rock (brecciated tuff)
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14032 (duplicate specimen sent to ASU)

Carbonea vorticosa (Florke) Hertel
Growth form: crustose
Substrate: rock
Site(s): near Deer Creek Trailhead
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14061

Catapyrenium lachneum (Ach.) R. Sant.
Growth form: squamulose
Substrate: soil on rocky outcrop
Site(s): along Deer Creek Trail
Relative abundance: common
Pollution sensitivity: unknown
Comment: there some variability in the specimens collected along Deer Creek Trail. Specimen #14036 has a gray convex thallus
Deposition of specimens: BYU Herbarium #14033 (duplicate specimen sent to ASU), 14034, 14035 & 14036 (duplicate specimen sent to John Thomson

Cladonia pyxidata (L.) Hoffm.
Growth form: squamulose
Substrate: gravelly soil
Site(s): along Deer Creek Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comment: none
Deposition of specimens: BYU Herbarium #14037 (duplicate specimen sent to ASU)

Collema polycarpon Hoffm.
Growth form: foliose
Substrate: rock
Site(s): along Deer Creek Trail
Relative abundance: rare - common
Pollution sensitivity: unknown
Comment: some thalli growing on cyanobacterial mats
Deposition of specimens: BYU Herbarium #14038 (duplicate specimen sent to ASU) & 14039 (material on cyanobacterial mats

Collema texanum Tuck.
Growth form: foliose
Substrate: rock
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comment: none
Deposition of specimens: BYU Herbarium #14067

Dermatocarpon miniatum (L.) Mann
Growth form: umbilicate
Substrate: rock
Site(s): along Deer Creek Trail
Relative abundance: locally common
Pollution sensitivity: sensitive to sulfur dioxide (Marsh and Nash, 1979)
Comment: this particular material is on the small side for this species
Deposition of specimens: BYU Herbarium #14100

Dermatocarpon reticulatum Magnusson
Growth form: foliose, umbilicate
Substrate: "mossy", shaded rock
Site(s): along Deer Creek Trail
Relative abundance: locally common - abundant
Pollution sensitivity: unknown (however, a closely related species D. miniatum is sensitive to sulfur (Marsh and Nash, 1979)
Comment: none
Deposition of specimens: BYU Herbarium #14040

Dimelaena oreina (Ach.) Norman
Growth form: crustose with effigurate margins
Substrate: on rock (brecciated tuff)
Site(s): along Deer Creek Trail
Relative abundance: common
Pollution sensitivity: unknown
Comment: none
Deposition of specimens: BYU Herbarium #14041 (duplicate specimens sent to ASU)

Diploschistes muscorum (Scop.) R. Sant.
Growth form: crustose
Substrate: over moss
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: sensitive to sulfur dioxides (Pisut, 1962)
Comment: none
Deposition of specimens: BYU Herbarium #14043

Diploschistes scruposus (Schreber) Norman
Growth form: crustose
Substrate: on rock (both brecciated tuff and igneous)
Site(s): along Deer Creek Trail
Relative abundance: rare - common
Pollution sensitivity: unknown
Comment: thalli were all KOH+ and C+
Deposition of specimens: BYU Herbarium #14042 (duplicate specimen sent to ASU)

Endocarpon pulvinatum Th. Fr.
Growth form: crustose - squamulose
Substrate: on rock
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comment: none
Deposition of specimens: BYU Herbarium #14044

Endocarpon pusillum Hedwig
Growth form: crustose
Substrate: on rock (brecciated tuff)
Site(s): along Deer Creek Trail
Relative abundance: rare - common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14006 (duplicate specimen sent to ASU)

Endocarpon wilmsoides Zahlbr.
Growth form: crustose
Substrate: on rocks
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14005

Flavoparmelia baltimorensis (Gyelnik & Foriss) Hale
Growth form: foliose
Substrate: on rocks
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: sensitive to sulfur dioxide (Hale, 1982)
Comments: none
Deposition of specimens: BYU Herbarium #14107

Flavopunctelia darrowi (Thomson) Hale
Growth form: foliose
Substrate: bark of pinyon pine
Site(s): along Deer Creek Trail
Relative abundance: rare - locally common
Pollution sensitivity: this species belongs to a group of lichens which are generally considered to be sensitive to various air pollutants
Comments: none
Deposition of specimens: BYU Herbarium #14045

Flavopunctelia flaventior (Stirton) Hale
Growth form: foliose
Substrate: bark of pinyon pine
Site(s): along Deer Creek Trail
Relative abundance: rare - common
Pollution sensitivity: sensitive to sulfur dioxide (Windler, 1977)
Comments: none
Deposition of specimens BYU Herbarium #14050

Flavopunctelia praesignis (Nyl.) Hale
Growth form: foliose
Substrate: on bark of oak
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: sensitive to sulfur dioxide (Nash, 1976)
Comments: none
Deposition of specimens: BYU Herbarium #14049 (duplicate specimen sent to ASU)

Flavopunctelia soredica (Nyl.) Hale
Growth form: foliose
Substrate: on bark of pinyon pine, mountain mahogany, juniper and oak, also on decorticated wood
Site(s): along Deer Creek Trail
Relative abundance: common - abundant
Pollution sensitivity: this species belongs to a group of lichens which are generally considered to be sensitive to various air pollutants
Comments: none
Deposition of specimens: BYU Herbarium #14046 (duplicate specimen sent to ASU), 14047 (duplicate specimen sent to ASU) and 14048 (duplicate specimen sent to ASU), 14051 (duplicate specimen sent to ASU) and 14052 (duplicate specimen sent to ASU)

Heppia lutosa (Ach.) Nyl.
Growth form: squamulose
Substrate: gravelly soil
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14053

Lasallia papulosa (Ach.) Llano
Growth form: foliose, umbilicate
Substrate: on rock
Site(s): along Deer Creek Trail
Relative abundance: locally common
Pollution sensitivity: intermediate sensitivity to sulfur dioxide (Wirth and Turk, 1974)
Comments: none
Deposition of specimens: BYU Herbarium #14054 (duplicate specimen sent to ASU)

Lecanora muralis (Schreber) Rabenh.
Growth form: crustose with lobed margins
Substrate: on rock
Site(s): along Deer Creek Trail
Relative abundance: common
Pollution sensitivity: tolerant, however, there are conflicting reports on this species. Some suggest that it may be somewhat sensitive to sulfur dioxide
Comments: none
Deposition of specimens: BYU Herbarium #14055 (duplicate specimen sent to ASU)

Lecanora novomexicana (B. de Lesd.) Zahlbr.
Growth form: crustose with lobed margins
Substrate: on rock, brecciated tuff
Site(s): along Deer Creek Trail
Relative abundance: common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14056 (duplicate sent to ASU)

Lecanora polytropa (Hoffm.) Rabenh.
Growth form: crustose
Substrate: on rock
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: thallus unusually well developed
Deposition of specimens: BYU Herbarium #14093

Lecanora saligna (Schrader) Zahlbr.
Growth form: crustose
Substrate: on decorticated juniper wood
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: intermediate sensitivity to sulfur dioxide (Wetmore, 1987)
Comments: none
Deposition of specimens: BYU Herbarium #14057 (duplicate specimen sent to ASU)

Lecidea tessellata Florke
Growth form: crustose
Substrate: on rock
Site(s): along Deer Creek Trail
Relative abundance: common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14059

Leprocaulon albicans (Th. Fr.) Nyl. ex Hue
Growth form: fruticose
Substrate: on soil in crevices of rocks
Site(s): along Deer Creek Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14063 (duplicate specimen sent to ASU)

Leptogium cyanescens (Rabenh.) Korber
Growth form: foliose
Substrate: on rock
Site(s): along Deer Creek Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium 14065 (duplicate specimen sent to ASU)

Leptogium denticulatum Tuck.
Growth form: foliose
Substrate: on rock
Site(s): along Deer Creek Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14064

Leptogium lichenoides (L.) Zahlbr.
Growth form: foliose with highly dissected margins
Substrate: on mossy rocks
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU #14066 (duplicate specimen sent to ASU)

Leptogium sp.
Growth form: foliose
Substrate: on mossy rocks
site(s): along Deer Creek Trail
Relative abundance: rare - locally common
pollution sensitivity: unknown
Comments: this species lacks fruiting bodies and does not have well-defined isidia, however, along the margins there are some squamiform isidia-like structures
Deposition of specimens: BYU 14065

Melanelia subolivacea (Nyl. in Hasse) Essl.
Growth form: foliose
Substrate: bark of pinyon pine
Site(s): along Deer Creek Trail
Relative abundance: locally common
Pollution sensitivity: moderately tolerant to oxidants (Nash and Sigal, 1980)
Comments: none
Deposition of specimens: BYU Herbarium #14068 (duplicate specimen sent to ASU)

Neofuscelia infrapallida (Essl.) Essl.
Growth form: foliose
Substrate: rock
Site(s): near Deer Creek Trailhead
Relative abundance: rare - common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14069

Pannaria leucophaea (Vahl) P. Jorg.
Growth form: squamulose
Substrate: soil over rock
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: sensitive to Sulfur dioxide (Hawksworth and Rose, 1970)
Comments: this specimen does not have any apothecia
Deposition of specimens: BYU Herbarium #14087

Parmotrema hababianum (Gyelnik) Hale
Growth form: foliose
Substrate: rock
Site(s): along Deer Creek Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14070 (duplicate specimen sent to ASU) &14071

Peccania arizonica (Tuck.) Herre
Growth form: minutely fruticose
Substrate: on soil
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14116

Peltigera canina (L.) Willd.
Growth form: foliose
Substrate: soil
Site(s): along Deer Creek Trail
Relative abundance: locally common
Pollution sensitivity: tolerant to sulfur dioxide (Hale, 1982), sensitive to oxidants (Sigal and Nash, 1983)
Comments: none
Deposition of specimens: BYU Herbarium #14075 (duplicate specimen sent to ASU)

Physcia aipolia (Ehrh. ex Humb.) Furnr.
Growth form: foliose
Substrate: on bark of mountain mahogany
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: intermediate sensitivity to sulfur dioxide (Wetmore, 1987)
Comments: ordinarily this species has abundant black apothecia, however, this specimen did not have any apothecia
Deposition of specimens: BYU Herbarium #14085

Physcia albinea (Ach.) Nyl.
Growth form: foliose
Substrate: rock
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14083

Physcia caesia (Hoffm.) Furnr.
Growth form: foliose
Substrate: on rock
Site(s): near Deer Creek Trailhead
Relative abundance: rare
Pollution sensitivity: intermediate sensitivity to sulfur dioxide (Dewitt, 1976)
Comments: none
Deposition of specimens: BYU Herbarium #14080 (duplicate specimen sent to ASU)

Physcia callosa Nyl.
Growth form: foliose
Substrate: on rock
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14082 (duplicate specimen sent to ASU)

Physcia crispa Nyl.
Growth form: foliose
Substrate: on bark of alligator juniper
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14086

Physcia stellaris (L.) Nyl.
Growth form: foliose
Substrate: on bark of juniper, oak, pinyon pine & mountain mahogany
Site(s): along Deer Creek Trail
Relative abundance: locally common
Pollution sensitivity: intermediate sensitivity to sulfur dioxide (Wetmore, 1987)
Comment: none
Deposition of specimens: BYU Herbarium #14076 (duplicate specimen sent to ASU), 14077, 14078, 14079 & 14081

Physconia enteroxantha (Nyl.) Poelt
Growth form: foliose
Substrate: on juniper bark
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: a closely related species (Physconia grisea) is classified as having intermediate sensitivity to sulfur dioxide.
Comment: none
Deposition of specimens: BYU Herbarium #14084

Physconia detersa (Nyl.) Poelt
Growth form: foliose
Substrate: soil over rocks
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: intermediate sensitivity to sulfur dioxide (Wetmore, 1987)
Comment: none
Deposition of specimens: BYU Herbarium #14088 (duplicate specimen sent to ASU)

Polychidium muscicola (Swartz) Gray
Growth form: minutely fruticose
Substrate: mossy rock
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comment: this is a new record for Arizona
Deposition of specimens: BYU Herbarium #14089 & 14115

Polychidium sp. 1
Growth form: minutely fruticose
Substrate: on bark at base of juniper
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comment: in most cases the thallus is minutely fruticose, however, in some places the thallus is flattened and almost foliose in appearance. A single apothecium was found
Deposition of specimens: BYU Herbarium #14090

Psora icterica (Mont.) Mull. Arg.
Growth form: squamulose
Substrate: on soil
Site(s): along Deer Creek Trail
Relative abundance: common - abundant
Pollution sensitivity: unknown
Comment: none
Deposition of specimens: BYU Herbarium #14091 (duplicate specimen sent to ASU)

Psora nipponica (Zahlbr.) G. Schneider
Growth form: squamulose
Substrate: soil and rocks
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comment: no apothecia on either specimen
Deposition of specimens: BYU Herbarium #14092 (on soil) & 14092a (on rock)

Punctelia hypoleucites (Nyl.) Krog
Growth form: foliose
Substrate: on mossy rocks, on bark of pinyon pine and on bark of cliffrose
Site(s): along Deer Creek Trail
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: there is some variation in the material depending on the substrate, however, the nature of the pseudocyphellae and the thallus and medullary chemistry is consistent
Deposition of specimens: BYU Herbarium #14072 (duplicate specimen sent to ASU), 14073 (on pinyon pine) & 14074 (on cliffrose)

Rhizocarpon disporum (Naeg. ex Hepp) Mull. Arg.
Growth form: crustose
Substrate: on rocks
Site(s): along Deer Creek Trail
Relative abundance: common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14095 (duplicate specimen sent to ASU)

Rhizocarpon intermediellum Rasanen
Growth form: crustose
Substrate: on rocks
Site(s): near Deer Creek Trailhead
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14096

Rhizoplaca chrysoleuca (Sm.) Zopf
Growth form: umbilicate
Substrate: on rock
Site(s): along Deer Creek Trail
Relative abundance: locally common
Pollution sensitivity: sensitive to sulfur dioxide (Hale, 1982), sensitive to oxidants (Nash, 1976)
Comments: none
Deposition of specimen: BYU Herbarium #140

Rinodina archaea (Ach.) Arnold
Growth form: crustose
Substrate: on decorticated wood
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14098

Sarcogyne sp.
Growth form: crustose
Substrate: rock
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: unknown
Comments: thallus brown with some prunosity; spores oblong, 5x2.5, many per ascus
Deposition of specimens: BYU Herbarium #14008

Staurothele fuscocuprea (Nyl.) Zsch.
Growth form: crustose
Substrate: on rocks
Site(s): near Deer Creek Trailhead
Relative abundance: rare - common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14099 (duplicate specimen sent to ASU)

Verrucaria lecideoides (Massal.) Trevisan
Growth form: crustose
Substrate: on rock
Site(s): near Deer Creek Trailhead
Relative abundance: rare
Pollution sensitivity: unknown
Comments: a new record for Arizona
Deposition of specimen: BYU Herbarium #14004

Xanthoparmelia conspersa (Ehrh. ex Ach.) Hale
Growth form: foliose
Substrate: on rocks
Site(s): near Deer Creek Trailhead
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14106

Xanthoparmelia cumberlandia (Gyelnik) Hale
Growth form: foliose
Substrate: on rocks
Site(s): near Deer Creek Trailhead
Relative abundance: common
Pollution sensitivity: sensitive to sulfur dioxide (Hale, 1982)
Comments: samples of this species were used for elemental analyses. Pb, S and Cu were evaluated
Deposition of specimens: BYU Herbarium #14103 (duplicate specimen sent to ASU)

Xanthoparmelia lineola (Berry) Hale
Growth form: foliose
Substrate: on rocks
Site(s): near Deer Creek Trailhead
Relative abundance: rare - common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14109

Xanthoparmelia nigropsoromifera (Nash) Egan
Growth form: foliose
Substrate: on rocks
Site(s): along Deer Creek Trail
Relative abundance: rare - common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14105

Xanthoparmelia novomexicana (Gyelnik) Hale
Growth form: foliose
Substrate: on rocks
Site(s): near Deer Creek Trailhead
Relative abundance: rare
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium 14112

Xanthoparmelia plittii (Gyelnik ex D. Dietr.) Hale
Growth form: foliose
Substrate: on rock (brecciated tuff), also on decorticated wood
Site(s): along Deer Creek Trail
Relative abundance: common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14102 (duplicate specimen sent to ASU) & 14108 (on decorticated wood)

Xanthoparmelia psoromifera (Kurok. ex Hale) Hale
Growth form: foliose
Substrate: on rocks
Site(s): near Deer Creek Trailhead
Relative abundance: locally common
Pollution sensitivity: unknown
Comments: none
Deposition of specimens: BYU Herbarium #14110 (duplicate specimen sent to ASU)

Xanthoparmelia somloensis (Gyelnik) Hale
Growth form: foliose
Substrate: on rocks
Site(s): along Deer Creek Trail
Relative abundance: rare
Pollution sensitivity: Unknown
Comments: none
Deposition of specimens: BYU Herbarium #14104

Xanthoparmelia wyomingica (Gyelnik) Hale
Growth form: foliose
Substrate: on gravelly soil
Site(s): along Deer Creek Trail
Relative abundance: common
Pollution sensitivity: unknow
Comments: none
Deposition of specimens: BYU Herbarium #14101 (duplicate specimen sent to ASU)

Xanthoria fallax (Hepp in Arnold) Arnold
Growth form: foliose
Substrate: bark of oak and juniper
Site(s): along Deer Creek Trail
Relative abundance: locally common
Pollution sensitivity: sensitive - intermediate sensitive to sulfur dioxide (Wetmore, 1987); tolerant to oxidants (Sigal and Nash, 1983)
Comments: none
Deposition of specimens: BYU Herbarium #14113 (duplicate specimen sent to ASU)

Combined species list for all wilderness areas:

Included with this report is a listing of all the lichen species from all seven Class I wilderness areas included in this project. This table includes current species names, general distribution information by wilderness and relative abundance information for each species. A total of 291 species in 82 genera were collected from all wilderness areas during the course of this project. Due to the fact that each wilderness area is somewhat unique in terms of substrates, microhabitats and physical factors, comparisons between wilderness areas based on absolute species numbers, or even relative abundance of selected species are probably invalid. Furthermore, there is some variance in the actual collecting time between wilderness areas. These species lists are preliminary and depending on the wilderness area, actually represent between 50 and 80% of the total lichen flora. Depending on the wilderness area somewhere between 7 and 12 days of additional collecting will be necessary to bring the list to between 90 and 100% completion.

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas
Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Acarospora							
cervina var. glaucocarpa				R	R-LC		
chlorophana	R-C	R-LC	LC				C
cinereoalba		R		LC	R-LC		
fuscata		C		C			LC
oligospora		R					
oxytona		LC	LC	LC			
peltastica		R					
scheicheri	R-C	LC					
strigata		C		LC		R	
sp. 1	R	R-C		R			R-LC
sp. 2	R	R					
sp. 3		R-LC					
sp. 4		R					
sp. 5		LA					
Anaptychia							
palmulata		C-A	LC			R-C	
Aspicilia							
alphoplaca	R-LC	R-LC	R-LC	LC	LC	R	R
caesiocinerea	R-C		R				
calcarea		C	LC	LC	LC	R-LC	C
cinerea	C	C	C		R-LC	LC	C-A
contorta							R

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Aspicilia (cont.)							
desertorum				R	LC		
radiosa		LC					
quartzitica	C		R-LC		R-LC		
sp. 1		R					
Bellemerea							
cinereorufescens				R-LC		R-LC	
Biatora							
botryosa				R			
Bryoria							
furcellata							A
simplicior							R
Buellia							
erubescens	R		R			R-LC	
lacteoidea							R-LC
lepidastra				R-LC			
mamillana		R					
puntata	R	R	R	R		R-LC	LC
retrovertens				R	R		
semitensis							R
spuria						R-LC	R
triphragmioides		R-LC					
turgescens	R						R-LC
sp. 1							R

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Caloplaca							
arizonica		LC	C		LC-C	R-LC	
cerina	R	LC	R			R-LC	LC
chysophthalma	R-C	LC	LC	R-LC	LC		
cinnabarina		C	C	R	LC		
discolor		C	LC			R-LC	
durietzii	C	R-C			LC		
epithallina						R	
exsecuta		R					
flavovirescens	C		C	LC	LC	LC	R
fraudans	R						
holocarpa	R-C	LC				R	LC
microphyllina						LC	
modesta				C		R-LC	LC
pelodella		R		C	LC		
saxicola		R				R	R
sideritis	R		R				
Candelaria							
concolor var. effusa			LC	R	R	LC	
Candelariella							
aurella	C	C					
deflexa	R-C	R	R	R			
rosulans	C	R-LC	LC	R-LC		LC	

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Candelariella (cont.)							
submexicana	R			LC			
vitellina		R-C	LC				
xanthostigma					R		
Candelina							
submexicana						LC	
Carbonea							
vorticosa	R	R					
Catapyrenium							
lachneum	C	LC-A		LC	LC	R	
Cetraria							
coralligera			LC				
weberi		LC					R
Chaenotheca							
furfuracea			R				
Cladonia							
bacillaris						R	
cariosa		R					LC
chlorophaea		LC					
coniocraea			LC				LC
fimbriata						LC	
pyxidata	LC	LC	R		LC		LC

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Collema							
coccophorum		R				R	
furfuraceum		R	R		LC	R	
fuscovirens				R	R-LC	R-LC	
polycarpon	R-C			LC	LC		
subflaccidum		LA					
tenax		LC				R-LC	
texanum	R						
undulatum		R					
Cyphelium							
tigillare		R-LC	R				R
Dermatocarpon							
intestiniforme					C		LC
miniatum	LC	LC-A	LA		C		LC
moulinsii			R				R
reticulatum	LC-A	R-C	LA	LC	LC		LC
Dimelaena							
oreina	C	R	LC				LC
Diploschistes							
diacapsis					LC		
muscorum	R				R		
scruposus	R-C	R-C	LC			R	R

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Diplotomma							
alboatrum			LC				
Endocarpon							
pulvinatum	R						
pusillum	R-C	LC		R	R		
wilmsoides	R						
Flavoparmelia							
caperata							LC
Flavopuntelia							
darrowi	R-LC		LC				R-LC
flaventior	R-C	R-LC			LC	R-LC	C
praesignis	R						LC
soredica	C-A	C	LA	R	LC	R-C	R-LC
Heppia							
lutosa	R						
Heterodermia							
hypoleuca							LC
rugulosa			R				
speciosa							R
Hyperphyscia							
adglutinata				LC	LC		
Hypocenomyce							
castaneocinerea							LC
friesii							LC

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Hypocenomyce (cont.)							
scalaris			R				LC
xanthococca			R				
Hypogymnia							
physodes							LC
Hypotrachyna							
pulvinata							C-A
Imshaugia							
aleurites							R-LC
placorodia		LC				R-LC	LC-A
Lasallia							
papulosa	LC						
Lecanora							
argopholis				R			
argentata		R	LC		R-LC	R	R-LC
caesiorubella			R				
subsp. saximontana							
carpinea							R
cenisia			R	R			R-LC
christoi		R		R-LC			
crenulata						R-LC	
dispersa		R					
garovaglii		R		R-LC			
impudens		R	R-LC				R-LC

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Lecanora (cont.)							
muralis	C	C	LC	C	LC	LC	
novomexicana	C		LC	R			
piniperda						R	R
polytropa	R						R
rugosella						LC	
rupicola							LC
saligna	R	R	R				R
sierrae		R				R	
symmicta						R	
thallophila					R		
valesiaca				R	R	R	
varia		R-LC				R	R
Lecidea							
atrobrunnea		R-LC	LC				R
auriculata		R-LC		R-LC			
botryosa	R						
elabens						R	
tessellata	C	C			LC	LC	LC
tornoensis							LC
turgidula		R-LC				LC	R
sp. 1		R					

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Lecidella							
carpathica		R				C	
euphorea		R-LC			R-LC	LC	LC
stigmatea		R	R-LC			LC	
viridans		LC					R
Lepraria							
finkii		R					R
Leprocaulon							
albicans	LC		R-LC				LC
Leproloma							
membranaceum			LC-A			R	
Leptogium							
arsenei					R	LC	LC
cyanescens	LC	R-LC	C		LC	LC	LC
denticulatum	LC		LC	R		LC	R-LC
furfuraceum		LC	LC		LC	LC	R
hirsutum			R				
lichenoides	R		R		LC		
saturninum		R				R-LC	
sp.	R-LC						
Letharia							
vulpina		R					

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Lichenothelia							
scopularia							R
Megaspora							
verrucosa		R	LC				
Melanelia							
exasperata		R-C		R			
halei						R	
incolorata		R-C					
olivacea						R	
olivaceoides					R		
subargentifera			R				
subolivacea	LC	C	R		R-LC		R-LC
substygia			LC				R
Mycocalicium							
subtile		R	R				R-LC
Neofuscelia							
infrapallida	R-C	R	LC	R-LC	R-LC	C	
Ochrolechia							
androgyna		R	R			R	R
pallescens		LA	LC				LC
Pannaria							
leucophaea	R		R		R-LC	R	R
tavaresii							R

Table 1: Species List & Relative Abundance Data for Arizona Wilderness Areas
Key: R=rare C=common A=abundant L=locally

Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Parmelia							
sulcata							R
Parmeliopsis							
ambigua		LC					LC
Parmotrema							
hababianum	LC		R-LC		LC	LC	
Peccania							
arizonica	R	R		R			
Peltigera							
canina	LC	LC			LC		LC
collina		R					
malacea		LC					R-LC
membranacea			LC		R-LC		
Peltula							
euploca				R			
Pertusaria							
albescens							R
amara			LC				
arizonica							R
saximontana		LC	LC		LC	R-LC	
sommerfeltii							R
wulfenioides							C-A

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Phaeophyscia							
cernohorskyi		R			LC	LC	
ciliata		R	R				LC
hispidula							LC
orbicularis		R	R				R-LC
sciastra		R	R				
Physcia							
aipolia	R		LC		R-LC	LC	
alba		R					
albinea	R					R-LC	R
caesia	R		R	R	R	R-LC	LA
callosa	R						R-LC
crispa	R						LC
dubia		R-LC	LC-A	R	R-LC		
halei						R	R-LC
phaea			R				
stellaris	LC	C	LA	R-LC	R-LC	LC	R-LC
subtilis		R	R				LC
Physconia							
detersa	R				R-LC	R	
enteroxantha	R		LC-A		R-LC	R	
grisea		R	LC-A				
perisidiosa		R	R		R		

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Placynthium							
nigrum			R				
Polychidium							
muscicola	R						
sp. 1	R						
Pseudevernia							
intensa							C-A
Psora							
decipiens		LC-A			LC		
himalayana					R		
ictérica	C-A			R-LC			
luridella					R	R	
nipponica	R		LC				R-LC
pseudorussellii					R		
tuckermanii		R			LC		
Punctelia							
hypoleucites	LC	LC	LC		R-LC		LC
subrudecta			R				R
Ramalina							
americana			R-LC				
pollinaria			LC-A				LC
sinensis		R	LC				R

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Rhizocarpon							
disporum	C	LC	C	LC	LC	C	LC
geographicum					R		
intermediellum	R		R				
Rhizoplaca							
chysoleuca	LC	R-LC	LC			R-LC	
melanophthalma		LC	R-LC				R
Rinodina							
archaea	R						
bischoffii		R					
confragosa			R				
exigua		R				R	R
milvina		R					
pachysperma		C			R-LC	R	
pyrina							LC
Sarcogyne							
regularis		R					
sp.	R						
Scoliciosporum							
umbrinum			R				
Squamarina							
degelii		R		R			

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Staurothele							
catalepta		R		C		LC	LC
fuscocuprea	R-C						
rufa		R					
Tephromela							
atra		LC	LC				R
Thelidium							
pyrenophorum				R			
Thyrea							
pulvinata				LC			
Toninia							
caeruleonigricans		LC					
tristis		LC					
Trapeliopsis							
granulosa		R					R
Tuckermannopsis							
fendleri		LC					C
pinastri							LC
Umbilicaria							
hirsuta							R
phaea			R				
torrefacta		LC	LC-A				
vellea			LC-A				

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Usnea							
arizonica							C
cavernosa							C
herrei							R
hirta		R-A	LC		R-LC	LC	R-LC
subfloridana							R-C
Verrucaria							
lecideoides	R						
muralis		LC					
nigrescens						R	
viridula		R		R			
Xanthoparmelia							
barbatica				R			
coloradoensis		C	LC	R-LC	LC	C	LC
conspersa	LC	LC					
cumberlandia	C	C		C	LC		R-LC
lineola	R-C	R	LC	LC			
monticola		R					
neoconspersa		R-LC					
neotaractica							R-LC
nigropsoromifera	R-C						
novomexicana	R					R	R
planilobata							R
plittii	C	R-LC		C			

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Genus/ Species	Galiuro	Sycamore Canyon	Sierra Ancha	Superstition	Mazatzal	Pine Mountain	Chiricuhua
Xanthoparmelia (cont.)							
psoromifera	LC	C					R
somloensis	R	LC					
subramigera				C	LC		
weberi				R			
wyomingica	C						
sp. 1		C					
sp. 2		R					
Xanthoria							
elegans		R			LC	R-LC	LC
fallax	LC	LC	LC	LC	R-LC	R-LC	
polycarpa		R-LC	LC				R-LC
sorediata		LC				LC	

AIR POLLUTION SENSITIVE LICHEN SPECIES
(Material collected for elemental analyses)

TABLE 2: List of air pollution sensitive lichen species collected from Galiuro Wilderness Area, Arizona. Growth form, substrate and site information is given for each species.

GENUS/SPECIES	GROWTH FORM	SUBSTRATE	COLLECTION SITE(S)
Dermatocarpon			
miniatum	foliose	rock	Deer Creek Trail
Rhizoplaca			
chrysoleuca	umbilicate	rock	Deer Creek Trail
Xanthoparmelia			
cumberlandia	foliose	rock	Deer Creek Trailhead
Xanthoria			
fallax	foliose	bark	Deer Creek Trail

Table 3: Elemental analysis data for selected species of lichens from reference sites in the Galiuro Wilderness Area, September 1990.

Species Sites (substrate)	Pb (ppm)	Cu (ppm)	S (%)
Xanthoparmelia cumberlandia	63.4 (61-67)	25.8 (21-30)	.274 (.24-.30)

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